

IN THE CLAIMS

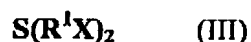
Claims 1-28 (Canceled)

29. (Previously Presented) A sol-gel coating material comprising:
- (A) an acrylate copolymer solution comprising at least one acrylate copolymer comprising a reaction product of:
 - a1) at least one (meth)acrylic ester that is substantially free of acid groups,
 - a2) at least one ethylenically unsaturated monomer comprising at least one hydroxyl group per molecule and is substantially free of acid groups, and
 - a3) at least one ethylenically unsaturated monomer comprising at least one acid group per molecule that is convertible into a corresponding acid anion group;
 - (B) a stock coating material comprising a hydrolysis and condensation product of at least one hydrolyzable silane of the general formula I

$$\text{SiR}_4 \quad (\text{I})$$
 wherein R is at least one of a hydrolyzable group, a hydroxyl group, and a nonhydrolyzable group with the proviso that there is at least one hydrolyzable group in the stock coating material;
- and
- (C) a sol comprising a hydrolysis, condensation, and complexing product of
 - C1) at least one hydrolyzable metal compound of the general formula II

$$\text{MR}_n \quad (\text{II})$$
 wherein:
 - M is at least one of aluminum, titanium, and zirconium,
 - R is at least one of a hydrolyzable group, a hydroxyl group, and a nonhydrolyzable group with the proviso that there is at least one hydrolyzable group in the compound, and
 - n = 3 or 4;

C2) at least one organic thio compound of the general formula III



wherein:

R^1 comprises a divalent radical derived from at least one of a first organic compound, a second organic compound, and a third organic compound:

wherein the first organic compound is at least one of an alkane, an alkene, a cycloalkane, a cycloalkene, an alkylcycloalkane, an alkylcycloalkene, an alkenylcycloalkane, and an alkenylcycloalkene, wherein the first organic compound is substituted or unsubstituted, wherein the first organic compound is linear or branched, and wherein the first organic compound contains no heteroatom or at least one heteroatom in the compound;

wherein the second organic compound is at least one of a substituted aromatic, an unsubstituted aromatic, a substituted heteroaromatic, and an unsubstituted heteroaromatic; and

wherein the third organic compound is at least one of an aromatic and a heteroaromatic, wherein the aromatic and the heteroaromatic are substituted with a substituent that is at least one of alkyl-, alkenyl-, cycloalkyl-, cycloalkenyl-, alkylcycloalkyl-, alkylcycloalkenyl-, alkenylcycloalkyl-, and alkenylcycloalkenyl, wherein the substituent is substituted or unsubstituted, and wherein the substituent contains no heteroatom or at least one heteroatom in the substituent;

X is at least one of -OH, -SH, and -NHR², wherein R² is at least one of a hydrogen atom, an alkyl group containing 1 to 6 carbon atoms, and a cycloalkyl group containing 1 to 6 carbon atoms;

and

C3) at least one hydrolyzable silane of the general formula I.

30. (Previously Presented) The sol-gel coating material of claim 29, wherein R^1 is derived from an unsubstituted, linear alkane containing 2 to 20 carbon atoms but no heteroatom in the chain.

31. (Previously Presented) The sol-gel coating material of claim 30, wherein R^1 is derived from at least one of ethane, propane, butane, pentane, and hexane.
32. (Previously Presented) The sol-gel coating material of claim 29, wherein $X = -OH$.
33. (Previously Presented) The sol-gel coating material of claim 32, wherein the organic thio compound comprises bis(2-hydroxyethyl) sulfide (thiodiethanol).
34. (Previously Presented) The sol-gel coating material of claim 29, wherein in the condensation of the sol, the condensation is conducted in the presence of a condensation catalyst that is at least one of an organic acid and an inorganic acid.
35. (Previously Presented) The sol-gel coating material of claim 34, characterized in that a molar ratio of the thio compound to condensation catalyst ranges from 0.8 : 1 to 1.2 : 1, and wherein the condensation catalyst comprises carboxylic acid.
36. (Previously Presented) The sol-gel coating material of claim 29, wherein the silane of the general formula I comprises a first silane and a second silane:
- a) wherein the first silane is at least one of i) a silane having four hydrolyzable groups R, and ii) a silane having three hydrolyzable groups R and one nonhydrolyzable group R without functional groups, and
 - b) the second silane is at least one of a silane having at least two hydrolyzable groups R and at least two nonhydrolyzable group R having at least one functional group.
37. (Previously Presented) The sol-gel coating material of claim 36, wherein a molar ratio second silane: first silane ranges from 1 : 20 to 1 : 1.
38. (Previously Presented) The sol-gel coating material of claim 36, wherein a molar ratio of thio compound to second silane ranges from 1 : 1 to 1 : 10.

39. (Previously Presented) The sol-gel coating material of claim 29, wherein an atomic ratio of metal M to silicon in the sol ranges from 1 : 10 to 1 : 1.5.
40. (Previously Presented) The sol-gel coating material of claim 29, wherein the sol-gel coating material is aromatics free.
41. (Previously Presented) The sol-gel coating material of claim 29, wherein the sol-gel coating material comprises, based on its total amount, 5 to 50% by weight of the acrylate copolymer solution, 5 to 40% by weight of the stock coating material, and 1 to 20% by weight of the sol.
42. (Previously Presented) The sol-gel coating material of claim 29, wherein, by solids contents of the acrylate copolymer, the stock coating material, and the sol, a weight ratio with respect to one another of (acrylate copolymer):(stock coating material):(sol) is (0.5 to 5):(1 to 10):1.
43. (Previously Presented) The sol-gel coating material of claim 29, wherein, in the general formulac I and II,
- i) the nonhydrolyzable groups R are at least one of an alkyl group; an alkenyl group; an alkynyl group; and an aryl group; and
 - ii) the hydrolyzable groups R are at least one of a hydrogen atom, an alkoxy group; an alkoxy-substituted alkoxy group of 3 to 20 carbon atoms; an acyloxy group; and an alkylcarbonyl group.
44. (Previously Presented) The sol-gel coating material of claim 43, wherein
- i) the hydrolyzable groups R are at least one of methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, sec-butoxy, beta-methoxyethoxy, acetoxo, propionyloxy, and acetyl; and
 - ii) the nonhydrolyzable groups R are at least one of methyl, ethyl, propyl, butyl, vinyl, 1-propenyl, 2-propenyl, butenyl, acetylenyl, propargyl, phenyl, and naphthyl.

45. (Previously Presented) The sol-gel coating material of claim 29, wherein the nonhydrolyzable groups R contain at least one of a functional group and a reaction product of the functional group with at least one reactive compound.
46. (Previously Presented) The sol-gel coating material of claim 29, wherein complexing is effected using organic compounds that form chelate ligands.
47. (Previously Presented) The sol-gel coating material of claims 29, wherein the sol-gel coating material is a sol-gel clearcoat material.
48. (Currently Amended) A process for producing mar-resistant sol-gel coatings on single-coat or multicoat paint systems comprising
- (i) applying a single-coat or multicoat paint system to a primed or unprimed substrate,
 - (ii) applying the sol-gel coating material of claim ~~1~~29 atop the single-coat or multicoat paint system, and
 - (iii) curing the sol-gel coating material.
49. (Previously Presented) The process of claim 48, wherein the sol-gel coating material is cured by irradiation with intermediate IR radiation.
50. (Previously Presented) The process of claim 48, wherein the single-coat or multicoat paint system has been completely cured.
51. (Previously Presented) The process of claim 48, wherein the single-coat or multicoat paint systems are one of an automotive original equipment manufacturing coating, an automotive repair coating, an industrial coating, a coil coating, a container coating, a plastics coating, and a furniture coating.
52. (Previously Presented) The sol-gel coating prepared by the process of claim 48.

53. (Previously Presented) The substrate prepared by the process of claim 48.
54. (Previously Presented) The process of claim 48, wherein at least one of the following:
- a) R^1 is derived from at least one of an unsubstituted, linear alkane containing 2 to 20 carbon atoms but no heteroatom in the chain; ethane; propane; butane; pentane; and hexane;
 - b) $X = -OH$;
 - c) the organic thio compound comprises bis(2-hydroxyethyl) sulfide (thiodiethanol);
 - d) the condensation is conducted in the presence of a condensation catalyst that is at least one of an organic acid and an inorganic acid;
 - e) the silane of the general formula I comprises a first silane and a second silane: wherein the first silane is at least one of i) a silane having four hydrolyzable groups R, and ii) a silane having three hydrolyzable groups R and one nonhydrolyzable group R without functional groups, and the second silane is at least one of a silane having at least two hydrolyzable groups R and at least two nonhydrolyzable group R having at least one functional group;
 - g) an atomic ratio of metal M to silicon in the sol ranges from 1 : 10 to 1 : 1.5;
 - g) the sol-gel coating material is aromatics free;
 - h) the sol-gel coating material comprises, based on its total amount, 5 to 50% by weight of the acrylate copolymer solution, 5 to 40% by weight of the stock coating material, and 1 to 20% by weight of the sol;
 - i) by solids contents of the acrylate copolymer, the stock coating material, and the sol, a weight ratio with respect to one another of (acrylate copolymer):(stock coating material):(sol) is (0.5 to 5):(1 to 10):1;
 - j) in the general formulae I and II,
 - i) the nonhydrolyzable groups R are at least one of an alkyl group; an alkenyl group; an alkynyl group; and an aryl group; and

- ii) the hydrolyzable groups R are at least one of a hydrogen atom, an alkoxy group; an alkoxy-substituted alkoxy group of 3 to 20 carbon atoms; an acyloxy group; and an alkylcarbonyl group;
- k) the nonhydrolyzable groups R contain at least one of a functional group and a reaction product of the functional group with at least one reactive compound;
- l) complexing is effected using organic compounds that form chelate ligands;
- m) the sol-gel coating material is a sol-gel clearcoat material.

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PATENT

(Docket No. IN-5551)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Manuela ARMBRUST

Serial No.: 10/049,532

Filed: February 12, 2002

For: Sol-Gel Coating

Group Art Unit: 1713

Examiner: William K. Cheung

I hereby certify that the attached correspondence is being transmitted via facsimile addressed to Commissioner for Patents, PO BOX 1450, Alexandria, VA 22313-1450, on the date shown below to facsimile number 1-703-872-9306.

6 May 2004
Date

Michael Morgan
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Commissioner for Patents

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Alexandria, VA 22313-1450

AMENDMENT AFTER NOTICE OF ALLOWANCE